Supporting Information


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General Information:

All reactions were carried out under air and monitored by TLC using Merck 60 F254 pre coated silica gel plates (0.25 mm thickness) and the products were visualized by UV detection. Flash chromatography was carried out with silica gel (200-300 mesh). FT-IR spectra were recorded on a Bruker Tensor-27 spectrometer. 1H and 13C NMR spectra were recorded on a Bruker Avance (III) 400 MHz spectrometer. Data for 1H NMR are reported as a chemical shift (δ ppm), multiplicity (s = singlet, d = doublet, q = quartet, m = multiplet), coupling constant J (Hz), integration, and assignment, data for 13C are reported as a chemical shift. High resolutions mass spectral analyses (HRMS) were carried out using ESI-TOF-MS. UV-visible spectra were recorded in a Varian Cary 100, TEM was recorded using Philips CM200 and powder XRD were recorded in a Bruker D8 Advance Model using Cu Kα as the X-ray Source. Thermal gravimetric analysis (TGA) experiments were performed in a Mettler-Toledo TGA-DSC/1 star® system.

Materials: Hydrogen tetrachloroaurate(III) hydrate, 4-aminothiophenol and 1-undecanethiol were purchased from Aldrich Chemicals. N,N-Dimethylformamide (DMF), hydrochloric acid (HCl) were purchased from Merck India. All these chemicals were used without further purification. Milli Q water was used throughout the experiment. The starting materials were either purchased from commercial sources or synthesized by known literature procedures.

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Synthesis of catalyst A:
To a stirred solution of 4-aminothiophenol (375 mg, 3.0 mmol) in DMF (20 mL) was added 20 mL of an aqueous solution of HAuCl₄ (394 mg, 1.0 mmol). The stirring was continued for 30 minutes at room temperature. The solution turned wine red immediately and finally became brownish blue indicating the formation of Au-NPs. The nanoparticles were precipitated by centrifugation at 10000 rpm, purified by washing with water and ether. Dialysis was performed against water to remove any unbound 4-aminothiophenol. The catalyst was finally freeze-dried using lyophilizer for characterization.
**Figure 1**: Scheme 1 represents the synthesis of 4-aminothiophenol coated Au-NPs (catalyst A). Transmission electron micrograph and corresponding particle size distribution of catalyst A as synthesized (a) after the first oxidation (b) after the 2nd oxidation (c). The nanoparticles were deposited from water. Scale bar 50 nm.

**Thermal Gravimetric Analysis (TGA) for calculation of Au content in catalyst A**

![TGA graph for 4-aminothiophenol coated Au-NPs (catalyst A)](image)

**Figure 2**: TGA graph for 4-aminothiophenol coated Au-NPs (catalyst A)

We performed TGA experiment to evaluate the amount of Au in catalyst A. For this, the 4-aminothiophenol coated Au-NPs were dialyzed against water overnight to remove the unbound 4-aminothiophenol and DMF. Then the nanoparticles were dried using lyophilisation and the dried sample was evaluated for Au content using TGA.

**Synthesis of catalyst B:**

The 1-undecanethiol capped Au-NPs were prepared by well-known Brust Method. To a stirred solution of tetraoctylammonium bromide (2.18 g, 4.0 mmol) in toluene was added an aqueous solution of HAuCl₄ (394 mg, 1.0 mmol) at RT. After vigorous stirring, the toluene solution turned violet indicating the transfer of AuCl₄⁻ to the organic phase. After removing the aqueous phase, 1-undecanethiol (564 mg, 3.0 mmol) was added to the toluene solution and was stirred for 30 minutes. Then NaBH₄ (190 mg, 5.0 mmol) was added and the reaction mixture turned
brownish indicating the formation of Au-NPs. The stirring was continued for overnight. Afterwards, the final catalyst was isolated by evaporating the organic solvents, followed by washing with ethanol, acetone and dried under vacuum.

\[ R = C_{11}H_{24} \]

**Figure 3:** (a) Schematic representation for 1-undecanethiol coated Au-NPs (catalyst B) (b) UV-Visible spectra of 1-undecanethiol coated Au-NPs in CHCl₃; the surface plasmon resonance peak at 510 nm confirmed the formation of Au-NPs. (c) TEM image of Au-NPs coated with 1-undecanethiol, the nanoparticles were deposited from toluene solution. Scale bar 100 nm.

**Oxidation procedure of α-hydroxy ketone:** To a stirred of heterogeneous mixture of (1.0 mmol) in water (10 mL) were added K₂CO₃ (276 mg, 2.0 mmol) and 4-aminothiophenol capped Au-NPs (28 mg, 4 atom %) at RT. Then reaction mixture was heated at specified temperature and time under air. The progress of the reaction was monitored by TLC. After completion of reaction, the mixture was extracted with ethyl acetate (3 × 10 mL), washed with water and brine. The organic phase was evaporated by rotary evaporator under reduced pressure to give the crude product which was further purified by column chromatography over silica gel to furnish the pure product.
All the products were characterized by corresponding spectroscopic data which were in good agreement with the reported data.

**Reuse the catalyst:** The recyclability of catalyst A was examined for the aerobic oxidation of benzoin. After completion of reaction, the organic compounds were extracted with diethyl ether (3 × 10 mL). The aqueous phase was isolated that was used for the next run. The TEM images were recorded from a concentrated aqueous solution as mentioned in figure 1.

\[
\begin{align*}
\text{Ar} & \xrightarrow{\text{K}_2\text{CO}_3, \text{H}_2\text{O}, \text{air heating}} \text{Ar} \\
\text{Ar} & \xrightarrow{\text{Au-NPs (4 atom%)}} \text{Ar}
\end{align*}
\]

**Synthesis of quinoxaline derivatives:** A mixture containing \( \alpha \)-hydroxy ketone (1.0 mmol), aryl 1,2-diamine (1.0 mmol), \( \text{K}_2\text{CO}_3 \) (2.0 mmol) and catalyst A (28 mg, 4 atom%) in 10 ml water was stirred and heated at 80 °C under air. After completion of reaction (monitored by TLC), the reaction mixture was extracted with ethyl acetate (3 × 10 mL). The organic layer was dried over anhydrous \( \text{Na}_2\text{SO}_4 \), followed by evaporation of solvent to obtain the crude product, which was purified by column chromatography over silica gel to give the pure product.

All the products were characterized by corresponding spectroscopic data (IR, \(^1\text{H NMR}, \text{\textsuperscript{13}C NMR}, \text{MS})). The known compounds were confirmed directly by comparing with literature data.

**2, 3-Bis(4-methoxyphenyl)quinoxaline-6-carboxylic acid (Table 3, entry 8):**

\[
\begin{align*}
\text{HOOC} & \xrightarrow{\text{N}} \text{N} \\
\text{OMe} & \xrightarrow{\text{N}} \text{N} \\
\text{OMe} & \xrightarrow{\text{N}} \text{N}
\end{align*}
\]
Yield: 328 mg, 85%; IR (KBr): ν 3426, 1691, 1605, 1513, 1298 cm\(^{-1}\); \(^1\)H NMR (DMSO-\(d_6\), 400 MHz): δ 3.83 (s, 6H), 6.99 (d, \(J = 8.8\) Hz, 4H), 7.52 (2d, \(J = 8.8\) Hz, 4H), 8.20 (d, \(J = 8.8\) Hz, 1H), 8.28-8.31 (m, 1H), 8.64 (s, 1H); \(^1\)C NMR (DMSO-\(d_6\), 100 MHz): δ 57.8, 57.9, 114.1, 129.5, 129.6, 131.0, 131.2, 131.3, 131.6, 131.7, 132.1, 139.9, 142.6, 154.0, 154.7, 160.4, 160.5, 167.1; ESI-MS: m/z 385.1385 (M-H)

2,3-Bis(2-thiophenyl)quinoxaline-6-carboxylic acid (Table 3, entry 10):

Yield: 304 mg, 90%; IR (KBr): ν 3422, 3096, 1696, 1621, 1543, 1520 cm\(^{-1}\); \(^1\)H NMR (400 MHz, DMSO-\(d_6\)) : δ 7.15-7.19 (m, 2H ), 7.31-7.34 (m, 2H), 7.86-7.89 (m, 2H), 8.15 (d, \(J = 8.8\) Hz, 1H), 8.28 (d, \(J_1 = 10.4\) Hz, 1H), 8.56 (s, 1H), 13.52 (s, 1H); \(^1\)C NMR (DMSO-\(d_6\), 100 MHz): δ 126.5, 126.6, 127.5, 128.4, 128.5, 128.8, 128.9, 129.0, 129.4, 130.9, 137.7, 139.1, 139.3, 140.4, 145.9, 146.5, 165.1; ESI-MS: m/z 337.0366 (M-H)

2, 3-Bis(2-furanyl)quinoxaline-6-carboxylic acid (Table 3, entry 13):

Yield: 266 mg, 87%; IR (KBr): ν 1694, 1615, 1570, 1487 cm\(^{-1}\); \(^1\)H NMR (400 MHz, DMSO-\(d_6\), ppm): δ 6.77-6.83(m, 4H), 7.93 (m, 2H), 8.15 (d, \(J = 8.8\) Hz, 1H), 8.26 (d, \(J = 8.8\) Hz, 1H), 8.55 (s, 1H); \(^1\)C NMR (100 MHz, DMSO-\(d_6\)): δ 111.0, 111.1, 112.1, 112.7, 127.8, 128.7, 129.4, 131.1, 137.8, 140.5, 141.6, 142.1, 143.9, 144.3, 148.7, 148.7, 165.1; ESI-MS: m/z 305.0756 (M-H)

Reference:
